

Claims

1. An axial-flow fan with double impellers comprising:

a housing having an air channel therein, the air channel having a suction opening portion on one of axial-end sides thereof and a discharge opening portion on the other axial-end side thereof;

a first impeller having a plurality of front blades and being adapted to rotate in the suction opening portion;

a first motor to rotate the first impeller about an axis of the fan in one of two rotating directions;

a second impeller having a plurality of rear blades and being adapted to rotate in the discharge opening portion;

a second motor to rotate the second impeller about the axis in the other rotating direction opposite to the one direction; and

a plurality of stationary blades radially extending and arranged stationary in the housing between the first impeller and the second impeller;

wherein the number of the front blades is five, the number of the stationary blades is three, and the number of the rear blades is four.

2. The axial-flow fan with double impellers as defined in claim 1, wherein the front blades are curved in a transverse cross section of the front blades as taken along a direction parallel to the axis so that concave portions

thereof are open toward the one direction;

wherein the rear blades are curved in a transverse cross section of the front blades as taken along a direction parallel to the axis so that concave portions thereof are open toward the other direction; and

wherein the stationary blades are curved in a transverse cross section of the front blades as taken along a direction parallel to the axis so that concave portions thereof are open toward the other direction and toward a direction in which the rear blades are positioned.

3. The axial-flow fan with double impellers as defined in claim 2, wherein the first impeller has an annular peripheral wall surrounding the axis on which base portions of the five front blades are integrally mounted; and

wherein the second impeller has an annular peripheral wall surrounding the axis on which base portions of the four rear blades are integrally mounted.

4. The axial-flow fan with double impellers as defined in claim 3, wherein a rotating speed of the second impeller is slower than that of the first impeller.

5. An axial-flow fan with double impellers comprising:

a first axial-flow fan unit which comprises: a first case including therein an air channel having a suction opening portion on one of axial-end sides thereof and a discharge

opening portion on the other axial-end side thereof; a first impeller having a plurality of front blades and being adapted to rotate in the suction opening portion; a first motor to rotate the first impeller about an axis of the fan in one of two rotating directions; and a plurality of webs circumferentially spaced apart and installed in the discharge opening portion to secure the first motor to the first case; and

a second axial-flow fan unit which comprises: a second case including therein an air channel having a suction opening portion on one of axial-end sides thereof and a discharge opening portion on the other axial-end side thereof; a second impeller having a plurality of rear blades and being adapted to rotate in the discharge opening portion; a second motor to rotate the second impeller about the axis in the other rotating direction opposite to the one direction; and a plurality of webs circumferentially spaced apart and installed in the suction opening portion to secure the second motor to the second case;

wherein the first case of the first axial-flow fan unit and the second case of the second axial-flow fan unit are coupled to form a housing;

wherein the plurality of webs of the first axial-flow fan unit and the plurality of webs of the second axial-flow fan unit are combined to form a plurality of stationary blades arranged stationary in the housing between the first impeller and the second impeller; and

wherein the number of the front blades is five, the number of the stationary blades is three, and the number of the rear blades is four.

6. The axial-flow fan with double impellers as defined in claim 5, wherein the front blades are curved in a transverse cross section of the front blades as taken along a direction parallel to the axis so that concave portions thereof are open toward the one direction;

wherein the rear blades are curved in a transverse cross section of the front blades as taken along a direction parallel to the axis so that concave portions thereof are open toward the other direction; and

wherein the stationary blades are curved in a transverse cross section of the front blades as taken along a direction parallel to the axis so that concave portions are open toward the other direction and toward a direction in which the rear blades are positioned.

7. The axial-flow fan with double impellers as defined in claim 6, wherein the first impeller has an annular peripheral wall surrounding the axis on which base portions of the five front blades are integrally mounted; and

wherein the second impeller has an annular peripheral wall surrounding the axis on which base portions of the four rear blades are integrally mounted.

8. The axial-flow fan with double impellers as defined in claim 7, wherein a rotating speed of the second impeller is slower than that of the first impeller.

9. An axial-flow fan with double impellers comprising:

a first axial-flow fan unit comprises: a first case including therein an air channel having a suction opening portion on one of axial-end sides thereof and a discharge opening portion on the other axial-end side thereof, and a first impeller having a plurality of blades and being adapted to rotate in the suction opening portion; and

a second axial-flow fan unit comprises: a second case including therein an air channel having a suction opening portion on one of axial-end sides thereof and a discharge opening portion on the other axial-end side thereof, and a second impeller having a plurality of blades and being adapted to rotate in the discharge opening portion;

wherein the first case of the first axial-flow fan unit and the second case of the second axial-flow fan unit are combined through a coupling structure;

wherein the coupling structure comprises: two kinds of engaged portions provided at an end portion surrounding a periphery of the discharge opening portion of the first case of the first axial-flow fan unit; and two kinds of engaging portions provided at an end portion surrounding a periphery of the suction opening portion of the second case of the second axial-flow fan unit and adapted to engage with the two

kinds of engaged portions;

wherein the two kinds of engaging portions and the two kinds of engaged portions include:

a first kind of the engaging portions and a first kind of the engaged portions together forming a first kind of engaging structure, the first kind of engaging structure being adapted to resist a separation operation when the first case and the second case in a coupled state are subjected to the separation operation which acts to axially separate the first case and the second case, the first kind of engaging structure being also adapted to resist a first rotation operation when the first case and the second case in a combined state are subjected to the first rotation operation which acts to rotate the first case about an axis relative to the second case in one of two rotating directions; and

a second kind of the engaging portions and a second kind of the engaged portions together forming a second kind of engaging structure, the second kind of engaging structure being adapted to resist a second rotation operation when the first case and the second case in a coupled state are subjected to the second rotation operation which acts to rotate the first case about the axis relative to the second case in the other direction opposite to the one direction.

10. The axial-flow fan with double impellers as defined in claim 9, wherein the first kind of the engaging portions and the first kind of the engaged portions together forming

the first kind of engaging structure are brought into an engaged state by bringing the end portion of the first case and the end portion of the second case close together, and the second kind of the engaging portions and the second kind of the engaged portions together forming the second kind of engaging structure are brought into an engaged state by rotating the first case about the axis relative to the second case in the one direction.

11. The axial-flow fan with double impellers as defined in claim 10, wherein the first kind of the engaging portion comprises: a hook having a first engaging surface and a second engaging surface, the first engaging surface being adapted to engage with a first engaged surface of the first kind of the engaged portion when the first case and the second case in a coupled state are subjected to the separation operation that acts to axially separate the two cases, the second engaging surface being adapted to engage with a second engaged surface of the first kind of the engaged portion when the first case and the second case in a coupled state are subjected to the first rotation operation that acts to rotate the first case about the axis relative to the second case in the one direction;

wherein the second kind of the engaging portion comprises: a protrusion having a third engaging surface, the third engaging surface being adapted to engage with a third engaged surface of the second kind of the engaged portion

when the first case and the second case in a coupled state are subjected to the second rotation operation that acts to rotate the first case about the axis relative to the second case in the other direction; and

wherein the first kind of the engaged portion comprises a first fitting groove having the first and second engaged surface, and the second kind of the engaged portion comprises a second fitting groove having the third engaged surface.

12. The axial-flow fan with double impellers as defined in claim 11, wherein the end portions of the first case and the second case have an almost rectangular outline respectively,

one of the hooks and one of the protrusions are integrally provided at each of at least three of four corner portions in the end portion of the first case, and

one of the first fitting grooves and one of the second fitting grooves are formed in each of at least three of four corner portions of the second case.

13. An axial-flow fan with double impellers comprising:

a first axial-flow fan unit which comprises: a first case including therein an air channel having a suction opening portion and a discharge opening portion on both axial-end sides thereof, and a first impeller having a plurality of blades and being adapted to rotate in the suction opening portion; and

a second axial-flow fan unit which comprises: a second case including therein an air channel having a suction opening portion and a discharge opening portion on both axial-end sides thereof, and a second impeller having a plurality of blades and being adapted to rotate in the discharge opening portion;

wherein the first case of the first axial-flow fan unit and the second case of the second axial-flow fan unit are combined through a coupling structure;

wherein the end portions of the first case and the second case have an almost rectangular outline respectively,

one first fitting groove and one second fitting groove are formed in each of at least three of four corner portions of the first case, and

one hook and one protrusion are integrally provided at each of at least three of four corner portions in the end portion of the second case;

wherein the hooks and the first fitting grooves are so shaped as to form a first kind of engaging structure, the first kind of engaging structure being adapted to resist a separation operation when the first case and the second case in a coupled state are subjected to the separation operation which acts to axially separate the first case and the second case, the first kind of engaging structure being also adapted to resist a first rotation operation when the first case and the second case in a combined state are subjected to the first rotation operation which acts to rotate the first case

about an axis relative to the second case in one of two rotating directions; and

wherein the protrusions and the second fitting grooves are so shaped as to form a second kind of engaging structure, the second kind of engaging structure being adapted to resist a second rotation operation when the first case and the second case in a coupled state are subjected to the second rotation operation which acts to rotate the first case about the axis relative to the second case in the other direction opposite to the one direction.